



Gesellschaft für Anlagen-
und Reaktorsicherheit
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ATHLET

Mod 3.1 Cycle A

Program Updates since
Mod 3.0 Cycle A

February 2016



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This document lists the major program modifications of the current ATHLET version since the last general release version Mod 3.0 Cycle A. It provides information not only for the ATHLET users but also for the developers, i.e. it contains details which are not relevant for normal code users.

Further information on program modifications relevant for ATHLET applications can be found under *Document Updates* of the User's Manual as well as under *Input Data Updates* of the ATHLET Input Data Description.

Bold face indicates that user's action may be required even for existing input decks.

1 Thermo-Fluidynamics

- 2D / 3D thermal-hydraulic model
 - 3D-model extension to cylindrical coordinates
 - BRANCH2M linkage for TFO of 3D domain automatically generated
 - Grid block coupling: Multidimensional simulation of junctions connecting two 2D/3D grid blocks
- Boron transport model extended for simulation of zinc-borate;
New GCSM process signal MASSBORA for plated boron / zinc-borate mass
- New MC gas ARGON
- Thermodynamic properties of water near the critical point improved
- Steady state calculation for two-phase flow at very low pressure (~ 1 bar) improved
- **MODELUNC: variation of further physical quantities, OHWFC is applied now for all liquid working fluids**
- Cross connection objects may now connect branches, too.
- New output quantity REFJ; mixture Reynolds number in junctions
- Steady state calculation: new TF or autonomous system may start with a SJP fill (followed by a branch)
- PW BRANCHING and PW BRANCH2M input data: new options ALL_IN and ALL_EX to provide all inflowing or outflowing, resp., pipes with the same branching data
- PW MIXLEVEL input data: less input data required for standard application of the ML/CL model

- MF term calculation for 2M model: Error in calculation of MF term of a junction downstream of a fill with vapor flow fixed.
- MF term calculation for 2M model: The upwind scheme has been replaced by an approach which sums up relevant contributions of both left and right side junctions. This improves simulation of counter current flow of adjacent junctions.
- Calculation of surface tension of liquid sodium improved.
- For IP shear, drift and friction loss calculation, bulk surface tension instead of saturation surface tension is used. This is more realistic for two phase flow with NC gas (e.g. liquid metal flow).

2 HECU

- New heat transfer model for condensation in horizontal tubes (Dobson&Chato)
- Heat transfer model for subcooled and saturated nucleate boiling (Chen) has been revised (suppression factor is one for horizontal bundles in crossflow; Thom correlation for estimation of temperature difference has been substituted by real temperature difference of preceding time step).
- Heat transfer correlations take bundle factor into account for flow parallel to tube bundles (factor according to Inayatov); **requ. input of pitch (TL0) in CW HEATCOND**
- Critical heat flux: Groeneveld look-up table replaces Doroschuk table; may optionally consider effect of fuel rod spacers on CHF calculation (s. PW SPACER)
- New input for location of spacer grids (used for Groeneveld look-up table)
- New HTC correlations for supercritical water available: see input variables `IHTC5L/R`
- Provision of a user supplied plug-in for HTC correlations for superheated water with heating surfaces
- The electrical heater model has been revised and is now ready for application.
- New input `EXCEPT_ACOMP0` for copied HCOs enables the use of new HCO component name instead of that of the master HCO.
- Time lag for surface temperature also for sub-CVs below ML (improves numerical stability)
- **New model: simulation of axial heat conduction inside HCOs (requ. Input of IAXH)**
- **Thermal radiation model has been revised. Two input cards have been added which allow easy modeling of radiation groups.**
- For HCOs coupled on both sides to fluid TFOs, the quench front model will now be applied at the *right* side (previously: left side). The left side will be assigned to the 'spontaneous' rewetting model.
- New properties package acc. to Y Philipponneau for MOX fuel of LM cooled reactors

3 Neutron Kinetics

- Point kinetics: The total core may be partitioned into two or more regions with different NK feedback coefficients. Then, the averaging of the fluid and fuel properties is done separately for these domains.

4 FEBE/FTRIX

- ...

5 Component Models

- New valve type: check valve with dynamic calculation of flap movement
- Call back hook for user-defined valve model
- Critical flow model CDR1D:
 - New basic equation system with temperature as solution variable (instead of specific enthalpy). Enables the application of all the ATHLET properties packages.
 - Applicable for H₂O, D₂O and helium
 - Range of application extended above the critical point (H₂O and D₂O)
 - Optionally considering a hydraulic diameter at the critical flow plane, which is different from that calculated from flow area; enables improved calculation of critical discharges through crack-like leaks.
 - Optionally considering one form loss coefficient per CDR1D table
 - Optionally considering one vena-contracta per CDR1D table
 - **Requires new input data in CW CDR1DIN**

6 GCSM

- New post-processing options: average left / right surface temperature
- **Plug-in (.dll or .so) for user-defined GCSM controller GUSER (replaces former user subroutine *guser.f*)**
- GCSM controller type EXTERNAL for calculation of GCSM signal by external user code
- Plug-in for general user provided GCSM controller

7 General

- ATHLET has been prepared for coupling of external modules via standardized coupling interface. Coupling can be established by plug-in or by callback function.
- Flexibility of algebraic operations on PARAMETERS increased.
- Max. Number of CVs per pipe is now limited to 9999 (before: 999).
- _EXP file (resolving INCLUDE directives) may be optionally complemented by a serial job number to make it distinct; useful if several ATHLET runs are executed at the same time, e.g. for uncertainty analyses.
- Several error messages improved
- **Input checks extended.**

8 GUI / Tools

- New ATHLET GCSM Modeler (AGM) for graphical modeling of control systems
- New design for creating / modifying plot design files (description of all curves of one plot in one window)
- New button to redefine the plot data file in the plot design file
- New button to modify the file of default settings
- ATHLET specific plug-in for Notepad++ editor